

## PATENT COOPERATION TREATY

## PCT

## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference JWB/SS/44720	<b>FOR FURTHER ACTION</b>		See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB00/03125	International filing date (day/month/year) 14/08/2000	Priority date (day/month/year) 12/08/1999	
International Patent Classification (IPC) or national classification and IPC G01L3/10			
<p>Applicant FAST TECHNOLOGY GMBH et al.</p> <p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 9 sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> <li>I <input checked="" type="checkbox"/> Basis of the report</li> <li>II <input type="checkbox"/> Priority</li> <li>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</li> <li>IV <input type="checkbox"/> Lack of unity of invention</li> <li>V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</li> <li>VI <input type="checkbox"/> Certain documents cited</li> <li>VII <input checked="" type="checkbox"/> Certain defects in the international application</li> <li>VIII <input type="checkbox"/> Certain observations on the international application</li> </ul>			

Date of submission of the demand 12/03/2001	Date of completion of this report 19.11.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Gerken, S Telephone No. +49 89 2399 6511



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB00/03125

## I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

### Description, pages:

1,2,4-7,10-19	as originally filed		
3,8,9	as received on	11/09/2001 with letter of	10/09/2001

### Claims, No.:

31-33	as originally filed		
1-30	as received on	11/09/2001 with letter of	10/09/2001

### Drawings, sheets:

1/3-3/3	as originally filed
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2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- the language of publication of the international application (under Rule 48.3(b)).
- the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- contained in the international application in written form.
- filed together with the international application in computer readable form.
- furnished subsequently to this Authority in written form.
- furnished subsequently to this Authority in computer readable form.
- The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

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4. The amendments have resulted in the cancellation of:

the description,      pages:  
 the claims,      Nos.:  
 the drawings,      sheets:

5.  This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes:	Claims 1-30
	No:	Claims
Inventive step (IS)	Yes:	Claims 1-30
	No:	Claims
Industrial applicability (IA)	Yes:	Claims 1-30
	No:	Claims

2. Citations and explanations  
**see separate sheet**

**VII. Certain defects in the international application**

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**

**INTERNATIONAL PRELIMINARY  
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International application No. PCT/GB00/03125

**Re Item V**

**Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Reference is made to the following documents:  
D1: US-A-4 697 460 (SUGIYAMA JUN ET AL) 6 October 1987  
cited in the application  
D2: FR-A-2 774 469 (ROULEMENTS SOC NOUVELLE) 6 August 1999 (1999-08-06)
  
2. The application relates to a transducer element for a torque or force transducer.
  
3. From the document D1 a torque or force transducer element is known which comprises a radially inner region, a radially outer region and a magnetised region (38 in Fig. 11) disposed between the inner and outer regions to be responsive to the transmitted stress and to emanate a stress-dependent magnetic field.
  
4. The transducer elements according to the independent **claims 1, 22 and 26** differ from D1 essentially in that the region disposed between the inner and outer regions to be responsive to the transmitted stress and to emanate a stress-dependent magnetic field is a region of permanent magnetisation.
  
5. Hereby alternative arrangements are provided.
  
6. None of the cited documents hint at such arrangements. In particular, D1 has no permanent magnetisation and requires continuous energisation of an AC-energised coil. D2 has small permanent magnets 8', but is not relying on the magnetoelastic effect. Hence, **claim 1** fulfils the requirements of novelty and inventive step, Art. 33(2) and (3) PCT.
  
7. **Claims 2 to 21, 23 to 25 and 27 to 30** are truly dependent claims relating to preferred embodiments of the transducer elements defined in the independent claims. Hence, they fulfil also the requirements of Art. 33(2) and (3) PCT.
  
8. The industrial applicability is evidently given for the subject-matter of all claims, Art. 33(4) PCT.

**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/GB00/03125

**Re Item VII**

**Certain defects in the international application**

1. The independent claims 1, 22 and 26 do not have the two-part form according to Rule 6.3.b PCT.
2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

*REPLACED BY  
34 AMDT*

magnetisation. The longitudinal magnetisation is applied to an annular region of a shaft or more than one such region.

Longitudinal magnetisation is the subject of our 5 copending International application PCT/GB00/ filed simultaneously herewith (Lloyd Wise, Tregear Case 44519) and published under the number It claims priority from the same British application GB 10 9919065.4 dated 12th August, 1999 from which the present application claims priority.

Both circumferential magnetisation and longitudinal magnetisation have been primarily applied to shafts or similar parts where torque is transmitted through the magnetised region in the direction of the shaft axis, e.g. 15 a load transmitting shaft having torque applied at one end and a load at the other end.

There is a need to measure torque in parts in which the load transmission is essentially radial. An example 20 is a disc-like structure mounted on a driven shaft and having drive means at its outer periphery, such as gear teeth. The drive may be in the opposite direction.

One proposal for torque measurement in an automobile transmission is disclosed in U.S. patent 4697460 (Sugiyama et al). An energiser coil/detection coil assembly is 25 non-contactingly placed adjacent a disc in which torque stress occurs. The energising coil is A.C. energised to establish an alternating magnetic flux in a flux path through the disc that is torque sensitive. The detection

displaced around the disc. Fig. 2 shows four such pairs of non-contacting sensors.

It will also be apparent that the torque sensor arrangement described can be used to measure torque in the 5 shaft 20 communicated to the disc when the outer periphery is held fixed or say under a braking force, or when torque is applied to the periphery and the shaft 20 is fixed or braked.

The orientation of a pair of diametrically opposite 10 Ms sensors 28a, 28b produce Ms components such that the sensors can be connected to add as far as Ms components are concerned but cancel the effects of an external field such as the Earth's magnetic field. The use of four sensors 28a-d in two orthogonally arranged pairs enables 15 the cancellation of external fields from any direction while adding the Ms components.

The use of multiple radial sensors 26 for the reference components Mr, particularly four sensors in two orthogonally arranged pairs, also enables connection in a 20 manner providing cancellation of any external field. The location of sensors to add wanted field components while cancelling external fields is discussed further in aforementioned concurrently filed PCT application  
PCT/GB00/ (Lloyd Wise, Tregeare Case 44719)

25 founded on GB 9919065.4.

The sensor devices for the transducer assembly are to one side of the disc 10. The magnetic efficiency can be enhanced by closing the magnetic path on the other side by

a member providing an annulus of high permeability material to bridge regions 12 and 14.

In the embodiment of Figs. 1 to 3, the disc is directly used as a load transmitting member. A disc or other plate-like member appropriately magnetised may also be used for torque measurement by securing the disc or plate to a load transmitting part or any part subject to a torque in its operation. For example Fig. 4 shows a part 30 which is revolving about an axis A-A so as to create a torque in the part. The part has a surface 32 at which the stresses due to the torque are expressed and a disc 34 of the kind shown in Fig. 2 is affixed to the surface 32. The disc 34 must be securely fixed to the surface, e.g. by screws 36, both radially inwardly and outwardly of the sensor region 22 so that the stresses are accurately reflected in this region.

To improve the magnetic efficiency of the disc the non-sensor side can have the magnetic path at transducer region closed by at least an annulus 38 of high permeability material acting between regions 12 and 14. The part 130 may itself provide this function.

Additional radially spaced regions of opposite polarity may be provided on the disc. These additional regions can form keeper or guard regions. Further discussion of keeper or guard regions will be found in concurrently filed application PCT/GB00/ (Lloyd Wise, Trengear Case 44719) claiming priority from GB 9919065.4.

Claims

1. A transducer element for a torque or force transducer comprising a member having a structure which extends generally radially of an axis to transmit a stress between a radially inner region of the structure and a radially outer region, and at least one magnetised region disposed between said inner and outer regions to be responsive to the transmitted stress and emanate a stress-dependent magnetic field.
5. 2. A transducer element as claimed in Claim 1 in which there are two magnetised regions, a radially inner region and a radially outer region between which a stress-dependent field is established.
10. 3. A transducer element as claimed in Claim 1 or 2 in which the or each magnetised region is arcuate with respect to said axis.
15. 4. A transducer element as claimed in Claim 1 or 2 in which the or each magnetised region is an interrupted annulus.
20. 5. A transducer element as claimed in Claim 1 or 2 in which each magnetised region is annular.
6. 6. A transducer element as claimed in any preceding claim in which said structure has a radially extending surface at which the or each magnetised region emerges.
25. 7. A transducer element as claimed in any preceding claim in which said member has a generally disc-like structure.
8. 8. A transducer element as claimed in any preceding

claim in which there are two magnetised regions; each being magnetised in an axial direction and the polarities of magnetisation of the two regions being opposite.

9. A transducer element as claimed in Claims 8 and 6 and 5 7 in which said structure having two radially-extending surfaces at which the or each magnetised region emerges and further comprising means located at one of said two surfaces to close a flux path between the two regions.

10. A transducer element as claimed in any one of Claims 10 1 to 7 in which there are two magnetised regions providing radially-spaced magnetic poles of opposite polarity at a surface of the member.

11. A transducer element as claimed in Claim 9 in which 15 a flux path linking said regions is closed within the material of said member.

12. A transducer element as claimed in any one of Claims 1 to 7 in which there are two magnetised regions, each being circumferentially magnetised and the polarities of circumferential magnetisation of the two regions being 20 opposite.

13. A transducer element as claimed in any one of claims 1 to 7 in which there is a single magnetised region which extends obliquely to said axis.

14. A transducer element as claimed in Claim 13 in which 25 said structure is generally disc-like and includes a step portion in which said single magnetised region is provided.

15. A torque sensing arrangement comprising a transducer

element arranged in a torque transmission path extending from one to the other of said radially inner and outer regions of said structure through said at least one magnetised region to emanate a torque-dependent magnetic field, and

a sensor system comprising one or more magnetic field sensors responsive to said torque-dependent magnetic field to provide a signal representing the torque transmitted through said torque transmission path.

10 16. A torque sensing arrangement comprising a transducer element which is as claimed in any one of Claims 1 to 14 and a sensor system comprising one or more magnetic field sensors responsive to said stress-dependent magnetic field to provide a signal representing the stress transmitted 15 between one and the other of said radially inner and outer regions.

17. A transducer element for a torque transducer comprising a member at least a portion of which is magnetisable and within which there is a first magnetised 20 region and a second magnetised region located radially inwardly of the first region with respect to an axis, said first and second regions both being longitudinally magnetised with respect to the direction of the axis and said first and second regions having their respective 25 longitudinal magnetisations of opposite polarity, a surface or interface transverse to said axis at or adjacent which said first and second regions terminate to provide a radially directed magnetic field extending

externally of said surface or interface with respect to the transducer element, said radially directed magnetic field being deflectable in response to a torque transmitted radially through said first and second regions to produce a circumferentially directed magnetic field component that is a function of the torque.

5 18. A transducer element as claimed in Claim 17 in which said circumferential component is zero at zero torque.

10 19. A transducer element as claimed in Claim 17 or 18 in which said member is adapted as a load transmitting part capable of transmitting a rotational drive applied radially within said annular regions to a load applied radially without said first and second regions or vice versa.

15 20. A transducer element as claimed in Claim 17, 18 or 19 in which said member is disc-shaped.

20 21. A transducer element as claimed in any one of Claims 17 to 20 in which said first and second regions are annular or at least one of the annular regions is an interrupted annulus, or said first and second regions are arcuate.

25 22. A transducer system comprising a transducer element as claimed in any one of Claims 17 to 21 and a magnetic field sensor device disposed and oriented to detect said circumferential magnetic field component and provide a signal representing same.

23. A transducer system as claimed in Claim 22 further comprising a magnetic field sensor device disposed and

oriented to detect said radial magnetic field and provide a signal representing same.

24. A transducer system as claimed in Claim 23 further comprising signal processing circuitry responsive to said signals representing the circumferential magnetic component and the radial magnetic field respectively to derive an output signal representing the circumferential magnetic component referred to the radial magnetic field.

25. A torque or force transducer element

10 comprising a member adapted to transmit torque or force applied along, on or about an axis extending through the member to a portion of the member spaced from said axis, or vice versa,

15 said member having a surface transverse to said axis, a first, outer, region located between said axis and said portion and extending to said surface;

a second, inner, region located between said axis and said outer region and extending to said surface,

20 said first and second annular regions, being magnetised with opposite polarity, and cooperating at said surface to generate a magnetic field component which is a function of said torque or force.

25 26. A transducer element as claimed in Claim 25 in which said first and second regions are annular and encircle said axis, or at least one of the annular regions is an interrupted annulus, or said first and second regions are arcuate with respect to said axis.

27. A transducer element as claimed in Claim 25 or 26 in

which said first and second regions are both longitudinally magnetised to develop a radial magnetic field component extending therebetween at said surface and a circumferential magnetic field component at said surface

5 that is a function of torque.

28. A transducer element as claimed in Claim 25 or 26 in which said first and second regions are both circumferentially magnetised to develop a radial magnetic field component at said surface as a function of torque.

10 29. A torque or force transducer assembly comprising first and second members coaxially disposed, said first member being of greater diameter than said second member,

15 a disc-like member extending generally radially of said axis and connecting said first member to said second member for transmitting force from one member to the other, said disc-like member comprising two magnetised annular regions that are at least arcuate or annular or are part annular,

20 said magnetised regions having a magnetisation such that the regions cooperate to generate a magnetic field component that is a function of a stress established in transmitting a load between said first and second members.

30. A transducer assembly as claimed in Claim 29 in which 25 said assembly is adapted to transmit torque from one of said members to the other.

31. A transducer assembly as claimed in Claim 29 or 30 in which said magnetised regions are longitudinally

magnetised with opposite polarities or circumferentially magnetised with opposite polarities.

32. A transducer assembly as claimed in Claim 29 in which said first and second members are mounted to cause flexing 5 of said disc-like member in response to relative axial displacement of the first and second members.

33. A transducer assembly as claimed in Claim 29 in which said first and second members are disposed to cause flexing of said disc-like member in response to a relative 10 displacement of said first and second members away from axial alignment.

# INTERNATIONAL SEARCH REPORT

Internal Application No  
PCT/GB 03125

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 G01L3/10 G01L1/12 G01L3/14

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 G01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 697 460 A (SUGIYAMA JUN ET AL) 6 October 1987 (1987-10-06) cited in the application column 4, line 29 -column 9, line 39; figures 1-3,6,11	1,3,5-7, 15,16
A	FR 2 774 469 A (ROULEMENTS SOC NOUVELLE) 6 August 1999 (1999-08-06) page 8 -page 16; claim 1; figure 1	30
A		1,15,17, 25,29

Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

\* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the International filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the International filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "R" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "W" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- "a" document member of the same patent family

Date of the actual completion of the international search

6 October 2000

Date of mailing of the international search report

17/10/2000

Name and mailing address of the ISA

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

Internal ref. no./Application No.  
**PCT/GB97/03125**

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 4697460	A 06-10-1987	JP	1981189 C	25-10-1995
		JP	6072825 B	14-09-1994
		JP	61059232 A	26-03-1986
FR 2774469	A 06-08-1999	WO	9940403 A	12-08-1999

10/04/93 2

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PCT/GB00/03123

## PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING  
OF A CHANGE(PCT Rule 92bis.1 and  
Administrative Instructions, Section 422)Date of mailing (day/month/year)  
07 March 2002 (07.03.02)Applicant's or agent's file reference  
PA/GV99 PCTInternational application No.  
PCT/GB00/03123

From the INTERNATIONAL BUREAU

To:

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TECHNOLOGY CENTER 2800

## IMPORTANT NOTIFICATION

International filing date (day/month/year)  
14 August 2000 (14.08.00)

1. The following indications appeared on record concerning:

 the applicant  the inventor  the agent  the common representativeName and Address  
DIXON, Antony, Robert  
&  
DIXON, Robert, BernardState of Nationality  
GBState of Residence  
GB

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

 the person  the name  the address  the nationality  the residenceName and Address  
THE BESK COMPANY LIMITED  
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3. Further observations, if necessary:

The applicants/inventors appearing in Box 1 have assigned all their rights to the  
applicant appearing in Box 2. They remain applicants/inventors for the US only.

4. A copy of this notification has been sent to:

 the receiving Office the designated Offices concerned the International Searching Authority the elected Offices concerned the International Preliminary Examining Authority other:The International Bureau of WIPO  
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